PART I. THE THRESHOLDS OF PHOTOFISSION IN URANIUM AND THORIUM.

PART II. EXPERIMENTAL DEPTH DOSE FOR 5, 10, 15, AND 20 MILLION VOLT X-RAYS

BY

HERMAN WILLIAM KOCH
B.S., Queens College, 1941
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PART I—THE THRESHOLDS OF PHOTOFISSION IN URANIUM AND THORIUM.

The detection of photofission[1] and the determination of the threshold energies in uranium and thorium is made possible by the high-energy continuous-spectrum of x-rays from the 20 million volt betatron[2]. By an observation of the fission yield as a function of betatron energy, an energy limit has been determined for the photofission process which is as sharp as any reported for single particle processes. The extrapolated energy at which the probability of fission induced by gamma-ray excitation increases steeply is defined as the threshold energy. These energies for uranium and thorium were found to be:

$$E_T(U^{238}) = 5.76\ (\pm 0.10)\ \text{M.E.V.}$$
$$E_T(Th^{232}) = 6.21\ (\pm 0.15)\ \text{M.E.V.}$$

The errors include an r. m. s. error of $\pm 1.7\%$ in the energy calibration as well as an estimated graphical error.

The plot of the total number of observed fissions per R recorded on a Victoreen intensity meter reveals a definite dissimiliarity in the functional variations with energy of the thorium and uranium cross-sections. Each yield curve shows a peak at approximately 1.7 M.E.V. above the threshold. The ratio of the two peaks is 1.8 in favor of the uranium. The thorium yield stays approximately constant after the peak while the uranium rises to a value of 8.6 times that of thorium at 13 M.E.V.

The complete interpretation of the shape of the fission yield curves is not permitted because of the lack of experimental information concerning the betatron x-ray spectrum. The interpretation should lead to conclusions of considerable interest in fission theory.

[1] Haxby, Shoupp, Stephens, and Wells, Phys. Rev., **59**, 57 (1941).
[2] Kerst, D. W., and Serber, R., Phys. Rev. **60**, 53 (1941).
Kerst, D. W., Rev. Sci. Instr. **13**, 387 (1942).

PART II.—EXPERIMENTAL DEPTH DOSE FOR 5, 10, 15, AND 20 MILLION VOLT X-RAYS.

Depth dose measurements in a phantom of tissue-like material have demonstrated the practical possibilities for deep therapy of the high voltage radiations from a 20 million volt betatron. At 20 M.E.V. the depth dose curves show:

(1) that the point of maximum dose is three centimeters below the surface of the phantom.

(2) that this maximum is three times greater than the surface dose.

At lower energies the maximum dose is nearer the surface and becomes less in magnitude. The results justify the trend in radiology towards using high voltage, because of less skin reaction and a greater depth dose.

Dr. P. Morrison[3] has presented a theory on the shape of these curves based upon the consideration of the Compton absorption process alone. The ionization maximum and its position in a phantom are determined solely from the range of the Compton electrons, which increases with voltage. However, in the increase of the voltage of the primary x-rays, the absorption coefficient is decreased, resulting in a dose at 10 centimeters which is two-thirds that of the peak ionization at 20 M.E.V. Thus the exit dose in therapy is likely to be greater than the entrance dose. Depression of the exit dose by the inverse square law could be achieved by decreasing the skin-target distrance. The present size of the betatron limits the proximity of a specimen to the inside target.

[3] Koch, H. W., Kerst, D. W., and Morrison, P., Radiology, **40**, 120 (1943).

VITA

Herman Wm. Koch was born September 28, 1920, in New York City, New York. He attended elementary and high school in that city. He attended Queens College, receiving the degree of Bachelor of Science in Physics in 1941. From 1941 to the present time he has attended the University of Illinois, where he held a teaching assistantship during 1941-1942, and a fellowship during 1942-1944. He received the degree of Master of Science from this institution in 1942. He is affiliated with Sigma Xi, Phi Kappa Phi, and the American Physical Society.